CLAIMS

1. A direct oxidation fuel cell, comprising:

(A) a membrane electrode assembly, including:

(i) a protonically conductive, electronically non-conductive membrane electrolyte having an anode face and an opposing cathode face; and

(ii) a catalyst coating disposed upon each of said anode face and said cathode face, whereby electricity-generating reactions occur upon introduction of an associated fuel including anodic disassociation of said fuel into carbon dioxide, protons and electrons, and a cathodic combination of protons, electrons and oxygen from an associated source of oxygen, producing water; and

(B) an anodic metallic diffusion layer disposed generally parallel to said anode face of said membrane electrode assembly and having a plurality of openings therein to allow said associated fuel mixture to pass therethrough to said anode face of said membrane electrode assembly to a contact point on said membrane to produce said electricity generating reaction, and to allow free electrons and carbon dioxide produced in said reactions to return back away from said membrane electrode assembly, and to allow unreacted fuel to return back from said membrane electrode assembly;

(C) a cathodic metallic diffusion layer disposed generally parallel to said cathode face of said membrane electrode assembly and having a plurality of openings therein to allow oxygen to pass therethrough to said cathode face of said membrane electrode assembly and protons, electrons and water to pass back away from said membrane electrode assembly; and

(D) a load coupled across said fuel cell providing a path for said free electrons produced in said electricity-generating reactions.

2. The direct oxidation fuel cell as defined in claim 1 wherein

said openings in at least one of said anodic metallic diffusion layer and said cathodic metallic diffusion layer comprise a plurality of pores formed in said metallic diffusion layer.

3. The direct oxidation fuel cell as defined in claim 1 wherein

at least one of said anode metallic diffusion layer and said cathode metallic diffusion layer comprise a porous metal that has said openings therein that allow substances to pass through said openings.

4. The direct oxidation fuel cell as defined in claim 1 wherein

said anodic metallic diffusion layer is comprised of stainless steel.

5. The direct oxidation fuel cell as defined in claim 1 wherein

said cathodic metallic diffusion layer is comprised of a material selected from the group consisting of nickel, copper, steel and combinations thereof.

6. The direct oxidation fuel cell as defined in claim 1 wherein

at least one of said anode metallic diffusion layer and said cathode metallic diffusion layer comprises a composition of loose pieces of metal that have spaces therebetween allowing substances to pass between the interstices of said metal pieces.

7. The direct oxidation fuel cell as defined in claim 1 further comprising

a first flow field plate disposed parallel to said anode metallic diffusion layer;

a second flow field plate disposed parallel said cathode metallic diffusion layer;

each of said flow field plates having grooves formed therein to direct the flow of substances within said fuel cell most efficiently across its respective metallic diffusion layer; and

a load connected between said first flow field plate and said second flow field plate to form an electrical circuit external to said fuel to extract electrons, and thus electricity, from said fuel cell.

8. The direct oxidation fuel cell as defined in claim 1 wherein said anode metallic diffusion layer performs as a flow field plate to conduct electrons produced in said electricity generating reactions and said load being connected at one end to said anode metallic diffusion layer to provide a path for said electrons out of said fuel cell as the electricity produced by said fuel cell.

9. The direct oxidation fuel cell as defined in claim 1 wherein said cathode metallic diffusion layer performs as a flow field plate to reunite electrons with protons that pass through said membrane and said load being attached at one end to said cathode metallic diffusion layer to reunite said electrons with said protons and reacting with oxygen at said cathode side of said fuel cell thus producing water.

10. The direct oxidation fuel cell as defined in claim 8 wherein said anode metallic diffusion layer performing as said flow field plate includes grooves formed therein to direct the flow of fuel to said anode face of said membrane electrode assembly.

11. The direct oxidation fuel cell as defined in claim 9 wherein said cathode metallic diffusion layer performing as said flow field plate has grooves formed therein to direct the flow of said oxygen across the cathode face of said membrane electrode assembly.

12. The direct oxidation fuel cell as defined in claim 1 wherein said fuel is selected from the group consisting of methanol, ethanol, propane, butane and aqueous solutions thereof, and combinations thereof.

13. A direct oxidation fuel cell system, comprising:

(A) a direct oxidation fuel cell including an anode, a cathode, and a membrane electrolyte disposed between the anode and the cathode;

(B) a source of fuel;

(C) a source of oxygen coupled to said cathode so as to produce electricity-generating reactions including anodic disassociation of said fuel to produce carbon dioxide, protons and electrons and a cathodic combination of protons, electrons and oxygen producing water;

(D) a gas separator coupled to receive said carbon dioxide produced at said anode;

(E) an anodic metallic diffusion layer disposed generally parallel to said anode face of said membrane electrode assembly and having a plurality of openings therein to allow said associated fuel mixture to pass therethrough to said anode face of said membrane electrode assembly to a contact point on said membrane to produce said electricity generating reaction, and to allow free electrons and carbon dioxide produced in said reactions to return back away from said membrane electrode assembly, and to allow unreacted fuel to return back from said membrane electrode assembly;

(F) a cathodic metallic diffusion layer disposed generally parallel to said cathode face of said membrane electrode assembly and having a plurality of openings therein to allow oxygen to pass therethrough to said cathode face of said membrane electrode assembly and protons, electrons and water to pass back away from said membrane electrode assembly; and

(G) a load coupled across said fuel cell providing a path for said free electrons produced in said electricity-generating reactions.

14. The direct oxidation fuel cell system as defined in claim 13 wherein

said openings in at least one of said anodic metallic diffusion layer and said cathodic metallic diffusion layer comprise a plurality of pores formed in said metallic diffusion layer.

15. The direct oxidation fuel cell system as defined in claim 13 wherein at least one of said anode metallic diffusion layer and said cathode metallic diffusion layer comprise a porous metal that has said openings therein that allow substances to pass through said openings.

16. The direct oxidation fuel cell system as defined in claim 13 wherein at least one of said anode metallic diffusion layer and said cathode metallic diffusion layer comprises a composition of loose pieces of metal that have spaces therebetween allowing substances to pass between the interstices of said metal pieces.

17. The direct oxidation fuel cell system as defined in claim 13 further comprising:

a first flow field plate disposed parallel to said anode metallic diffusion layer;

a second flow field plate disposed parallel said cathode metallic diffusion layer;

each of said flow field plates having grooves formed therein to direct the flow of substances within said fuel cell most efficiently across its respective metallic diffusion layer; and

a load connected between said first flow field plate and said second flow field plate to form an electrical circuit external to said fuel to extract electrons, and thus electricity, from said fuel cell.

18. The direct oxidation fuel cell system as defined in claim 13 wherein said anode metallic diffusion layer performs as a flow field plate to conduct electrons produced in said electricity generating reactions and said load being connected at one end to said anode metallic diffusion layer to provide a path for said electrons out of said fuel cell as the electricity produced by said fuel cell.

19. The direct oxidation fuel cell system as defined in claim 13 wherein said cathode metallic diffusion layer performs as a flow field plate to reunite electrons with protons that pass through said membrane and said load being attached at one end to said cathode metallic diffusion layer to reunite said electrons with said protons and reacting with oxygen at said cathode side of said fuel cell thus producing water.

20. The direct oxidation fuel cell system as defined in claim 13 wherein said anode metallic diffusion layer performing as said flow field plate includes grooves formed therein to direct the flow of fuel to said anode face of said membrane electrode assembly.

21. The direct oxidation fuel cell system as defined in claim 13 wherein said cathode metallic diffusion layer performing as said flow field plate has grooves formed therein to direct the flow of said oxygen across the cathode face of said membrane electrode assembly.

22. The direct oxidation fuel cell system as defined in claim 13 wherein said fuel is selected from the group consisting of methanol, ethanol, propane, butane and aqueous solutions thereof, and combinations thereof.

23. A direct oxidation fuel cell system comprising:

(A) a direct oxidation fuel cell means including an anode, a cathode, and a protonically conductive, electronically non-conductive membrane electrolyte disposed between the anode and the cathode;

(B) means for providing oxygen coupled to said cathode so as to produce electricity-generating reactions including anodic disassociation of a fuel and water mixture to produce carbon dioxide, protons and electrons and a cathodic combination of protons, electrons and oxygen producing water;

(C) means for providing a fuel and water mixture to said fuel cell;

(D) means for distributing said fuel and water mixture generally evenly to said anode, and said means for distributing being of a substantially metallic composition; and

(E) means for distributing said oxygen generally evenly to said cathode, and said means for distributing being substantially of a metallic composition.

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